Fuel Cell Measurement System CLCS Gateway

Implementation Plan and Impact Assessment

84K00049-001

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1. Introduction

In an effort to provide Space Shuttle Vehicle system engineers further insight into the health of fuel cells on-board the Orbiter, additional instrumentation is scheduled to be installed on each Orbiter beginning in August 1997. The new system is presently refered to as the Fuel Cell Measurement System (FCMS). Approximately 96 measurements will be added to each of the three fuels cell. Data collected by the FCMS will be transmitted to the the Ground via the T-0 interface and a dedicated hardline between the Pad (or OPF) and the LCC. This document describes short term and long term impacts to CLCS Gateway development.

2. CLCS Short Term Support - Consolidated SDS Gateway Solution

Data will be provided to the user community via the CLCS Consolidated Shuttle Data Stream Gateway[1] (CSDS). Additional functionality will be added to the CSDS Gateway that will allow the Gateway to receive and decommutate the FCMS PCM stream and provide measurement data to PC-Goal workstations via SDS' in the Firing Rooms. The CCMS data bank will be modified to include the new measurements. PC-Goal Displays will be developed.

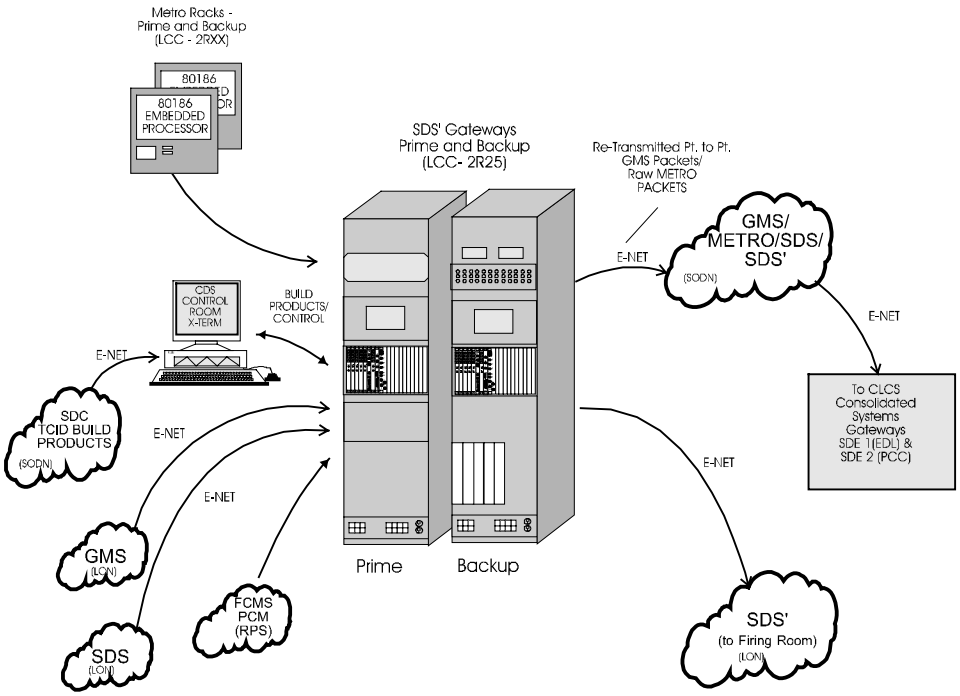

Figure 1: Consolidated SDS Gateway Data Flow

[1] For more information on the Consolidated SDS Gateway see the Consolidated SDS Gateway System Design Document (84K00XX).

2.1 Work Required/Completion Date/Responsible Person

1. Develop FCMS PCM Decom/Packetizer Software (Complete) (C. Le)
2. Install New Software into Consolidated Systems Gateway (Complete) (C. Le)
3. Develop PC-Goal Display Skeletons (Complete) (R. Lee)
4. Install New Hardware into Consolidated SDS Gateway (Complete) (J. Ferguson)
5. Install Cables between RPS and Consolidated SDS Rack in room 2P10 (Complete) (J. Ferguson)
6. Add FCMS FDIDs to Data Bank (Complete) (C. King)
7. Develop FCMS Validation Plan (Complete) (L. Velencia/S. Quinn)
8. Validate CSDS Hardware, Software and PC-Goal Display Skeletons (Complete) (CLCS/USA Team, Lisa Valencia - Lead)
9. Determine the mechanism to transfer funds between CLCS and Orbiter Upgrades (J. Fox)

Targeted Completion Dates for all these activities is September 9, 1997.

Dependencies:

Supply complete definition of FCMS PCM format (J. Engle)
Supply Linearization coefficients (J. Engle)
List of all required user pseudo FDs (J. Fox)
Required date for both of these dependencies: June 30, 1997

2.2 Hardware Costs

Additional hardware will be installed in the Consolidated SDS Gateways in the LCC. Table 1 lists the new hardware to be installed and the costs.

Table 1: Hardware Costs

Item Number	Name	Price Each	Quantity	Sub Total
1.	PCM Bit Sync/Decommuator	$15,000	6	$90,000
2.	MVME 167 CPU	$5,000	6	$30,000
3.	MVME 712 Module	$500	6	$3,000
3.	Signal Conditioner	$1500	6	$9,000
4.	Cables	GFE	4	$0
Grand Total				$132,000

Note: The PCM Bit Sync/Decoms are on-site and available for use for this activity. The hardware was originally procured to support CLCS PCM Downlink Gateway development. The quantity of required Decoms and CPU Boards and associated hardware has been increased over earlier measurements to accommodate simultaneous FCMS tests and for spares. These replacement costs will be covered with Orbiter Upgrades Funds. The mechanism to transfer these funds is TBD.

2.3 Labor Assessment

The labor required to develop software to process the FCMS PCM stream is very similar to software that is planned for use in the CLCS PCM Downlink Gateway. Thus it is some what difficult to separate work that it is being done specifically for the FCMS project and the PCMS D/L Gateway except in a few cases. The following table lists labor required specifically for FCMS software development:

Pseudo FDID Calculations (Software)	80 hours (Inet)
FEPC and GCP kernel modifications	40 hours (USA)
Hardware installation	20 hours (USA)
Documentation (Test plan, design documents)	40 hours (NASA 20, USA 20)
Subsystem Test at Aydin Vector	80 hours (NASA 40, Inet 40)
Systems Test (FCMS only)	40 hours (NASA 20, USA 20)
Comm Labor[2]	40 hours (USA)
Total	340 hours

2.4 Other Expenditures

Travel to Aydin Vector for Vendor System Test	$2,500 (for two engineers, one trip)

2.5 Short Term Solution Comments

1. A maximum of two simultaneous FCMS tests will be supported at time.
2. CDS Recording will not be supported. Recording and Retrievals will be possible via SDC.
3. Recording with the existing PC-Goal facilities will be supported.

[2] This activity was performed to verify the FCMS PCM Master could properly drive the comm lines between the PAD and the LCC and between the OPF and the LCC.

LONG TERM SOLUTION PROVIDED FOR INFORMATION ONLY

3. Long Term CLCS Solution - CLCS PCM Downlink Gateway

The long term solution requires the development of additional PCM downlink software and applications (console displays). First demonstration of CLCS equipment with flight hardware is currently scheduled for March of 1999. First flow is scheduled for December of 2000.

3.1 Summary of Work Required

Additional functionality will be added to the CLCS PCM Downlink Gateway that will allow the Gateway to receive and decommutate the FCMS PCM stream and provide measurement data to CLCS Console Workstations. A PCM Bit-synchronizer/decommuator and signal conditioning board will be added to each PCM Downlink Gateway in the three CLCS Pad/VAB Gateway Groups, the three OPF Gateway Groups, the two IDE Gateway Groups and the two SDE Gateway Groups. A Gateway FCMS CSC will be developed as part of the PCM Downlink Services CSCI. FCMS applications will be developed to display FCMS data on CLCS Consoles.

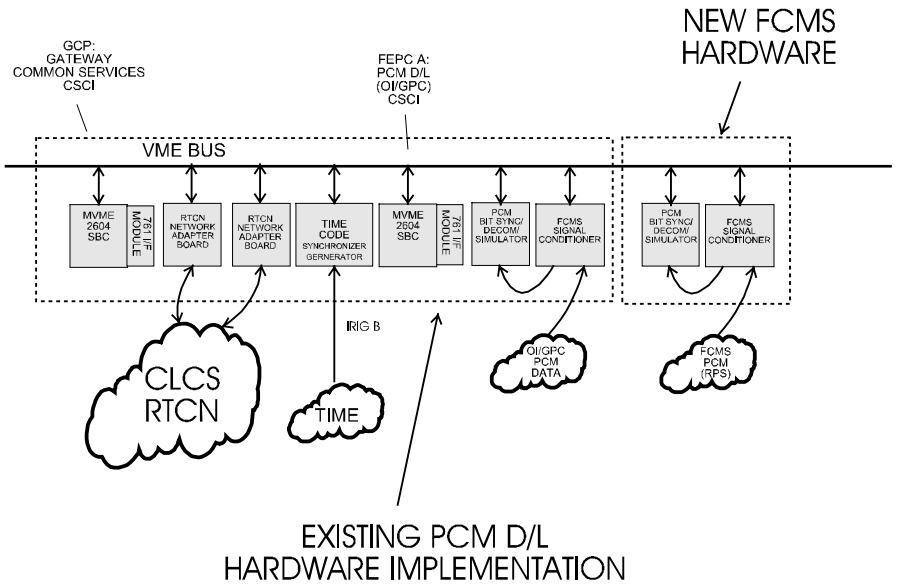

Figure 2: CLCS PCM Downlink Gateway VME Telemetry Processor

Table 2: Long Term Solution Hardware Costs

Item Number	Name	Price Each	Quantity[3]	Sub Total
1.	PCM Bit Sync/Decommuator	$10,000[4]	23	$230,000
2.	Signal Conditioner	$1,000	23	$23,000
Grand Total				$253,000

These funds will be costed in FY 98 and FY 99

3.2 Long Term Solution Labor Costs

TBD

3.3 Long Term Solution - Comments

1. SDC Recording and Retrievals will be supported.
   Simultaneous FCMS testing with multiple vehicles will be supported.

[3] Current CLCS designs require dedicated Gateway Groups for each facility (OPFs, Pad, etc.). This figure includes Active, Stand-by, and Hot-Spare units in operational and development sets.
[4] Includes expected discounts associated with a large volume buy. This includes equipment for CLCS development and test environments (SDE 1 & 2, IDE 1 & 2).

List of Acronyms

CLCS - Check-out and Launch Control System
FCMS - Fuel Cell Measurement System
IDE - Integrated Development Environment
SDE - Satellite Development Environment